

Dyeing Techniques of fabric in Ancient India: Indigo and Madder as important Natural Dyes

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Abstract

*This paper probes the dyeing methods used in ancient India, taking the indigo from *Indigofera tinctoria* and madder from *Rubia cordifolia*. Evidence is taken from prehistorically archaeological sites to Indus Valley urban centers, and from primary texts such as Vedic hymns and Buddhist scriptures. Secondary analyses confirm the use of these dyes in the Indus Valley Civilization, where indigo and madder derived from indigenous plants created colorful textiles. Indigo, (nila in Sanskrit), produces a blue dye from leaf fermentation, while madder, or manjistha, red dyes from root extracts. Archaeological studies finds include cotton fragments from Mohenjodaro (ca. 3000 BC) containing alizarin residues and evidence of indigo fermentation vats. Literary sources describe dye applications: the Rigveda references multicolored garments for elites; the Asvalayana Grihyasutra specifies red dyes for warriors; and the Majjhima Nikaya emphasizes cloth preparation to ensure even dyeing. The Arthashastra regulates dye production and taxation. Techniques involved anaerobic fermentation for indigo (converting indican to leuco-indigo) and mordant-assisted boiling for madder (using alum to bind alizarin to fibers). These methods, spanning 7000 BCE to 200 CE, relied on local plants, avoided synthetic chemicals, and supported sustainable textile production, trade, and social structures. This analysis highlights the chemical and cultural roles of these dyes in ancient Indian society.*

Key words: dye, indigo, madder, textile,

Introduction

Ancient Indian dyeing centered on natural pigments extracted from plants, transforming fibers like cotton and wool into durable colored textiles. Key dyes included indigo from *Indigofera tinctoria* leaves, requiring reduction-oxidation processes for blue hues, and madder from *Rubia cordifolia* roots, providing alizarin for red shades. These dyes held symbolic value: blue represented celestial themes, red denoted vitality and status.

Sources for this study are primary: archaeological data from sites like Mehrgarh and Arikamedu, and texts including the *Rigveda*, *Arthashastra*, and Buddhist canons. Secondary scholarship synthesizes these, tracing indigo and madder from Vedic to Mauryan periods as integral to textile industries. Dyeing originated in Neolithic times (ca. 7000 BC) with basic pigment applications on burial textiles and evolved into organized production by the Mauryan period (ca. 300 BC), supporting exports. Sections cover archaeological evidence, literary descriptions, technical processes, and socioeconomic impacts. These methods used as fermentation and plant-based mordants—contrasting modern synthetic dyes and offering insights into sustainable textile system.

Methodology

This study adopts a qualitative historical research approach, integrating interdisciplinary methods to analyze ancient Indian dyeing techniques, with a focus on indigo and madder dyes. The methodology emphasizes textual exegesis, archaeological corroboration, and comparative synthesis, drawing on primary and secondary sources to reconstruct practices without experimental reconstruction.

Primary data collection involved compiling archaeological reports from Mehrgarh, Mohenjo-daro, Harappa, and Arikamedu, for material evidence of dyes and tools, and ancient texts like Vedic literature, Dharmasutras, epics, Buddhist and Jain canons, and the *Arthashastra* for references. Texts were selected for chronological range, c. 7000 BE–200AD, and relevance to dyes, colors, and processes, with key terms like *nila* (indigo) and *manjistha* (madder) traced across corpora.

Secondary sources, including scholarly articles and monographs, provide analytical frameworks and chemical insights (e.g., HPLC for alizarin/indigotin detection in residues). Analysis employed thematic coding to categorize references by dye type, technique, and context, followed by cross-referencing to trace evolution and cultural roles. Comparative tables (e.g., site evidence, textual prescriptions) facilitated pattern identification, while symbolic interpretations linked dyes to social hierarchies. Limitations include organic material degradation, addressed via chemical proxies and multi-source triangulation for validity.

Archaeological Evidence

Archaeological remains provide direct evidence of dyeing materials, tools, and products. At Mehrgarh, 7000–5500 BC, a burial textile impression shows red and black pigments, likely from madder roots or early indigo precursors, applied via immersion.

In the Indus Valley Civilization (3300–1300 BC), Mohenjo-daro yields cotton fragments (ca. 2500 BC) with alizarin traces, indicating madder root decoction followed by mordanting with alum. Blue residues suggest indigo vats: leaves fermented anaerobically in sealed jars to produce soluble leuco-indigo, then oxidized on fabrics. Harappa features mineralized cotton on corroded copper artifacts (44 threads/cm), dyed with madder and indigo in resist patterns. The "Priest-King" steatite figurine depicts a trefoil-patterned cloak with red (madder), white (lime-bleached), and blue (indigo) bands, possibly achieved through tie-resist or block-printing techniques. Chanhudaro shows silk beads with degummed fibers prepared for madder immersion, alongside jute and wool samples. By the 1st–2nd centuries CE, Arikamedu port sites reveal brick-lined vats for indigo reduction-oxidation, with exported cloths valued at 17 dinars per pound.

These findings show widespread use of local dyes, facilitating trade with Mesopotamia. Chemical analyses confirm alizarin and indigotin presence, linked to nearby *Rubia* and *Indigofera* growth. Artifacts like spindle whorls and vat shards suggest specialized workshops.

Literary Evidence: Vedic to Mauryan Periods

Ancient texts document dye sources, applications, and regulations, integrating dyeing into religious, social, and economic contexts.

Vedic and other Texts (c. 1500–200 BC)

The *Rigveda* mentions *citra-vasas* literally “brightly coloured” or “many-hued garments. (multicolored garments) for rituals, implying plant-based dyes.¹ Later Vedic texts describe extracts from *lodhra* flowers, madder roots, and indigo leaves yielding whites, reds, yellows, greens, blues, and blacks.

According to the *Brihadaranyaka Upanishad*,² mentions the use of scarlet madder dye for sacred garments, highlighting the ritual importance of colour in early Vedic traditions. Similarly, the *Asvalayana Grihyasutra*,³ different social groups used specific natural dyes for the **sacred** thread ceremony. *Brahmins and Vaishyas* wore threads dyed yellow with turmeric, while Kshatriyas used a light red dye made from madder (*manjistha*).

The *Dharmasutras* established clear colour codes for clothing and dyes according to social order. The *Gautama Dharmasutra* assigns madder-red garments to warriors, turmeric-yellow to merchants, and resin-based colours to priests, while explicitly forbidding red dyes for novices.⁴ Meanwhile, Panini’s *Ashtadhyayi* mentions *manjistha* (madder) as a commonly used dye, showing how natural colouring agents were part of everyday life as well as ritual practice.⁵

Epic Texts (ca. 400 BCE–400 CE)

The *Ramayana* describes multicolored wedding garments and variegated silks dyed with safflower (*kusumba*) and madder.⁶ mentioning dyers (*rangakara*). The *Mahabharata* uses dye metaphors for permanence and notes madder reds, indigo blues, and *kusumba* cultivation.

Buddhist and Jain Texts (ca. 500 BCE–200 CE)

Jain stories follow suit, using soda to bleach cloth before dipping in madder for reddish robes; holy folks picked plain ochre tones. The *Charaka Samhita* notes *manjistha* works double duty—as a dye and a healing plant.⁷

Ancient Buddhist writings make dyeing monk robes a simple, everyday task tied to deeper lessons. The *Jataka* tales share easy ways to get colors from nature: roots, barks, and leaves for blue (*nila*), red from *manjistha*, and other shades.⁸ These old ways mix nature, care, and wisdom, showing how pure starts lead to vibrant lives.

Mauryan and Post-Mauryan Texts (ca. 300 BCE–200 CE)

The *Arthashastra* regulates madder and *kusumba* production, taxing fields and standardizing wool dyes to "pure red" and "rose-red" Dyers receive premium wages. Sangam literature praises indigo cloths (*nilikanchchai*) for trade value; the *Periplus of the Erythraean Sea* records indigo exports.

Detailed Dyeing Techniques

Dyeing processes required precise preparation and chemical manipulation. In ancient India, dyeing fabrics was an art that turned plain cloth into vibrant masterpieces. It all started with prepping the fabric, think of it as giving it a deep clean. People would scour the material using alkaline solutions or even urine to strip away dirt, oils, and impurities. This step, mentioned in the *Majjhima Nikaya* (an old Buddhist text), made sure the dyes soaked in evenly, like prepping a canvas for a painting.

Study about madder, the go-to for those gorgeous reds and pinks. They harvested roots from the *Rubia*

cordifolia plant—a tough, red-rooted weed—and ground them into a powder. Then, they'd simmer it in water at around 80–100°C for an hour or two, extracting the magic color compound called alizarin. To make it stick to the fibers, they added mordants like alum (a mineral salt) or turmeric. These acted like glue, forming bonds between the dye and the cloth. The fabric—usually cotton or wool—got dunked in this mix at 60–80°C for half an hour to an hour. Boom: soft pinks on lighter weaves, deep crimson on wool. The *Arthashastra*, an ancient guide to running an empire, even laid down rules for keeping shades consistent, probably to avoid any shady deals in the marketplace.

Indigo was a whole different beast for those moody blues. Folks chopped up leaves from the *Indigofera tinctoria* plant and packed them into sealed vats with water and fermenting stuff like fruit scraps. Over two or three days at room temp (25–30°C), without oxygen, the leaves broke down indican into leuco-indigo—a clear, soluble form of the dye. Then dip wet fabric right in, then pull it out to the air. Magic happened: the leuco-indigo turned back to insoluble blue indigotin, locking onto the fibers like a stubborn stain actually want. The *Mahavagga*, part of Buddhist scriptures, shares tips on boiling setups to cut down on waste—smart and efficient.

Over-dye yellows on top of indigo blues. To make colors last through washes and sun, they used extra mordants like lime (calcium hydroxide) for better grip. Dyeing guilds, called *rangakara*, turned this into big business.

These skilled crews scaled up using stuff right from the backyard—plants, minerals, waste—no fancy chemicals. It was low-impact, earth-friendly wizardry that colored saris, banners, and trade goods for centuries.

Economic and Social Dimensions

Dyeing drove economic activity: Indus textiles exported to Sumer; *Arthashastra* taxed madder fields and paid dyers premiums; guilds (*rajaka*) employed women in processing. Socially, colors signified hierarchy—*Grihyasutra* reds for warriors, *Vinayapitaka* earth tones for monks versus lay blues. Indigo symbolized divinity, madder vitality; restrictions like *Apastamba's* indigo ban maintained purity. The *Periplus* highlights trade integration, exporting cultural motifs via dyes.

Conclusion

From Mehrgarh pigments to *Arthashastra* regulations, indigo and madder dyes integrated into ancient Indian rituals (*Dharmasutras*), ethics (*Mahavagga*), and commerce (*Periplus*). Their plant-based, low-waste techniques exemplify early sustainable chemistry, emphasizing slow extraction for durable colors. Modern applications could revive these methods for eco-textiles.

References

- [1] Rigveda. Edited by Vishwa Bandhu. Hoshiyarpur: Vishveshvaranand Vedic Research Institute, 1963. (Hymns 10.85: pp. 1450–1452).
- [2] Brihadaranyaka Upanishad. Translated by Max Müller. Delhi: Motilal Banarsidass, 1965. (II.3–6: pp. 112–115).
- [3] Asvalayana Grihyasutra. Edited by N.N. Sharma. Delhi: Motilal Banarsidass, 1976. (1.19.9: pp. 45–46).
- [4] Gautama Dharmasutra. Translated by Patrick Olivelle. Dharmasutras. Oxford: Oxford University Press,



1999. (1.19–21, 7.10, 9.4: pp. 28–30, 45–46)

[5] Pāṇini. *The Ashtadhyayi of Panini*. Translated and edited by S.M. Katre. Poona: Deccan College, 1987. (IV.2.2; IV.3.138)

[6] Ramayana. Edited by Pandit Shivram Sharma. Chaukhambha Vidya Bhawan Varanasi, 2002, (II.83.15),

[7] Charaka Samhita. Various editions. (Manjistha: Chikitsa Sthana, Ch. 23, pp. 567–569).

[8] Jataka. Edited by V. Fausbøll. London: Pali Text Society, 1883–1907. (Vol. VI, p. 279).